Ontario
Ministry of Agriculture and Food
Jack Riddell, Minister

RESEARCH IN TRANSITION

THE RED MEAT PLAN

91-05985/

# DIRECT AND MATERNAL EFFECTS ON BEEF CATTLE

J.W. Wilton and E.B. Burnside,
Department of Animal and Poultry Science,
University of Guelph

The traits in cattle of pre-weaning gain (WG) and calving ease (CE) are referred to commonly as 'maternal traits'. Although both affect net production efficiency to a great extent, much of genetic selection is still based on post-weaning gain performance. At present, however, maternal genetic evaluations are lacking on the basis of which beef producers could make selection decisions.

Maternal traits have two genetic aspects: 'direct effects' and 'maternal effects'. The first is that part of a calf's performance which is determined by its own genes, that is, the combination of sire and dam; the second is the effect due to the dam's influence on her calf for reasons other than the genes she has contributed to it.

In this study, the direct and maternal effects for both WG and CE were separated and the heritabilities of each estimated.

## JUSTIFICATION FOR SEPARATE ESTIMATES OF HERITABILITY

There are a number of reasons for separating the two sources of genetic variation:

1. direct and maternal effects appear to be correlated negatively with each other; thus, heavy emphasis on direct effects, or traits closely related such as post-weaning gain, may lead to poorer maternal performance and decreased production efficiency;
2. from an economic point of view, it may be more desirable to place more selection emphasis on one of either direct or maternal effects and improve the other through better nutrition and management;
3. producers may wish to select specifically for direct or for maternal effects in order to create either sire or dam lines for use in cross-breeding.

## OBJECTIVES OF THE STUDY

This study was undertaken with the following objectives in mind:

1. to estimate the heritabilities and relationships of direct and maternal effects on weaning weight;
2. to use the best possible genetic evaluation method for both the direct (growth) and maternal (milk) effects on weaning weight;
3. to develop a within-herd evaluation modified by also using across-herd sire evaluations;
4. to determine the accuracy of the modified within-herd evaluation compared to a complete across-herd evaluation.

## EXPERIMENTAL DESIGN

Data from the ROP as edited for use in the Canadian Beef Sire Monitoring Program were used. There were sufficient data on five breeds to measure genetic parameters (heritability).

All evaluations were strictly within breed. The model accounted for the effects of the contemporary group of animals identified by herd, year, season, age of dam, and sex of calf. Maternal effects were identified through maternal grandsires.

Two sets of data were available to test the evaluation methods. One was from the Canadian Hereford Association which had 136,900 records by 5,800 sires. The other was on 29,100 Simmental by 4,000 sires as recorded under ROP.

## SUMMARY OF RESULTS

The heritabilities and genetic correlations are shown in Table 1. In this study, heritabilities for each breed were fairly similar for both direct and maternal effects. Thus, genetic improvement in both traits should be possible.

Direct heritabilities for WG, as shown in Table 1, were similar to those in the literature. Any differences between heritability estimates should reflect true genetic differences, but also could be due to characteristics of the animals represented in the data.

**Table 1. Genetic parameter estimates for preweaning gain**

| | HERITABILITIES | | CORRELATION |
|---|---|---|---|
| BREED | DIRECT (D) | MATERNAL (M) | D/M |
| Angus | .39 | .21 | – .54 |
| Hereford | .30 | .27 | – .42 |
| Simmental | .43 | .20 | – .45 |
| Charolais | .27 | .16 | – .26 |
| Shorthorn | .39 | .26 | – .14 |

For example, breeds having a few major lines in the data may have lower genetic variation, and hence heritabilities, than those with a broader genetic background.

Maternal heritability of WG was lower than direct heritability in all breeds. Maternal effects are considered to be primarily due to milk production, but may be related to maternal behaviour as well. Estimates were within the range expected for milk production.

On the other hand, there was a negative correlation between direct and maternal effects for WG; that is, animals with good growth ability tended to be poor milkers. These results are consistent with most reports in the literature. The reason for this negative correlation is not clear.

The correlations between the modified within-herd evaluations and across-herd ones are shown in Table 2. In general, these were high, much higher than simple within-herd evaluations.

Direct heritability estimates for CE were higher than many reports in the literature (Table 2). The direct effect is thought to be primarily due to calf size, that is, weight and shape, but may also be due to hormonal processes. The emphasis on size and height in the beef industry may be responsible for increased genetic variability in calving ease. The result of this is heritabilities which are higher than expected.

**Table 2. Genetic parameter estimates for calving ease**

| | HERITABILITIES | | CORRELATION |
|---|---|---|---|
| BREED | DIRECT (D) | MATERNAL (M) | D/M |
| Angus | .28 | .22 | – .43 |
| Hereford | .17 | .13 | – .15 |
| Simmental | .21 | .27 | – .27 |
| Charolais | .33 | .23 | – .74 |
| Shorthorn | .19 | .19 | – .32 |

Maternal heritability estimates tended to be lower than direct ones for CE. Maternal effects are likely due to the size of the pelvic opening and its shape as well as hormonal response when the cow gives birth. The results show that genetic progress is possible. Changes in the maternal characteristics of calving ease may be slow, but should contribute to greater efficiency in a cow herd in the long run.

The direct/maternal correlation for CE was sufficiently negative to suggest that selecting for one would be detrimental to the other. It is commonly felt that the negative correlation is caused by the relationship between a calf's size at birth and the size of the dam. For example, a calf which has a low weight at birth would tend to be born earlier than the average time; however, with a lower mature weight, she could have greater problems calving.

## IMPLICATIONS OF RESULTS FOR BREEDING SELECTION

It is feasible to separate direct and maternal portions of performance for bulls, based on progeny test information. Separating these effects is important for increasing the flexibility of breeding programmes and net production efficiency. The results show that:

1. Both the direct (growth) and maternal (milk), contributions to weaning weight are sufficiently heritable to improve them through genetic selection;
2. The negative correlation between direct and maternal effects is such that attention must be paid to both in selecting breeding animals.

Methods were developed and shown to work in evaluating both direct and maternal effects. An approach which is recommended is to have an annual across-herd evaluation followed by within-herd ones modified at least by previously calculated sire evaluations.

It is clear from this research that reasonable genetic progress can be expected for either WG or CE; however, given the negative correlation of these traits, the relative emphasis the breeder puts on one or the other of them will depend on costs in the cow herd.